IN THE CLAIMS:

The text of all pending claims is provided for the convenience of the Examiner.

1. (ORIGINAL) A method of estimating a motion of an image of frames organized into a hierarchical structure, the method comprising:

performing searches on lower level frame data using initial search points to obtain search points with minimum Sum of Absolute Difference (SADs) and using the search points with the minimum SADs as a based motion vector; and

performing searches on upper level frame data and upper level field data using the based motion vector to obtain the search points with the minimum SADs and using the search points with the minimum SADs as frame and field motion vectors.

2. (ORIGINAL) The method of claim 1, wherein in obtaining the frame and field motion vectors, top to top (Top2Top) and bottom to bottom (Bot2Bot) field motion vectors are estimated with reference to inter-field SADs obtained upon frame motion estimation, the based motion vector is scaled, and searches based on the scaled based motion vector are performed on top to bottom (Top2Bot) and bottom to top (Bot2Top) fields to obtain motion vectors with the minimum SADs.

3. (ORIGINAL) The method of claim 2, wherein the based motion vector is scaled according to a scaling coefficient which considers a distance between fields.

4. (ORIGINAL) The method of claim 3, wherein if the distance between identical fields is m, the distance between different fields is n, and the based motion vector is BMV, the Top2Bot and Bot2Tp field motion vectors are BMV×n/m.

5. (ORIGINAL) An apparatus to estimate a motion of an image of frames organized into a hierarchical structure, the apparatus comprising:

a pre-processor performing low-pass filtering and subsampling on a current frame and a reference (previous) frame to organize the current frame and the reference frame into a hierarchical structure;

a first motion estimation unit performing a search on frame data obtained by the pre-processor at a low resolution level and searching for at least one initial search point with a minimum Sum of Absolute Difference (SAD); and

a second motion estimation unit setting the at least one initial search point as a based frame and field motion vectors and performing the search on the frame data obtained by the pre-processor at a high resolution level by using the based frame and field motion vectors to estimate frame motion vectors and the field motion vectors with the minimum SADs.

6. (ORIGINAL) The apparatus of claim 5, wherein the second motion estimation unit comprises:

a frame motion estimation unit performing frame and field searches on the high resolution level frame data by using the motion vectors obtained from the low resolution level frame data to estimate the frame motion vectors with the minimum SADs and top to top (Top2Top) and bottom to bottom (Bot2Bot) field motion vectors with the minimum SADs;

a first scaler scaling the based motion vector, depending on a distance between a top field of the current frame and a bottom field of the previous frame;

a first field motion estimation unit performing vertical and horizontal local searches on the top to bottom fields at the high resolution level by using the based motion vector scaled by the first scaler to estimate a top to bottom (Top2Bot) field motion vector with the minimum SAD;

a second scaler scaling the based motion vector, depending on the distance between the bottom field of the current frame and the top field of the previous frame;

a second field motion estimation unit performing vertical and horizontal local searches on the bottom to top fields at the high resolution level by using the based motion vector scaled by the second scaler to obtain a bottom to top (Bot2Top) field motion vector with the minimum SAD.

7. (ORIGINAL) An image encoding system, comprising:

a discrete cosine transform (DCT) unit performing a DCT on incoming image data;

a quantization unit quantizing the DCT image data;

a dequantization unit dequantizing the quantized image data;

an inverse DCT (IDCT) unit performing IDCT on the dequantized image data;

frame memory storing the IDCT image data on a frame-by-frame basis;

a motion estimation unit sampling the image data of a current frame and the image data of a previous frame stored in the frame memory resulting in a hierarchical structure for each frame, and estimating frame and field motion vectors at a high resolution level based on motion vectors obtained from frame data at a low resolution level; and

a variable length coding unit removing statistical redundancy from the quantized image data using the motion vectors estimated by the motion estimation unit.

8. (ORIGINAL) An apparatus to estimate a motion of an image of frames organized into a hierarchical structure, the apparatus comprising:

a discrete cosine transform (DCT) unit performing a discrete cosine transform (DCT) function on the image;

a quantization (Q) unit quantizing the DCT function image;

a dequantization unit dequantizing the quantized image;

an inverse DCT (IDCT) unit performing an inverse discrete cosine transform (IDCT) on the dequantized image;

a frame memory (FM) storing the IDCT image on a frame-by-frame basis;

a motion estimation (ME) unit forming a hierarchical frame structure by sampling image data of a current frame and the image data of a previous frame stored in the FM, and performing a frame motion estimation by applying based motion vectors (MVs); and

a variable length coding (VLC) unit removing statistical redundancy from the quantized image based on the MVs estimated by the ME unit.

9. (ORIGINAL) The apparatus of claim 8, wherein the ME unit comprises:

a pre-processor performing low-pass filtering (LPF) on the current frame and the previous frame and organizing each of the current and reference frames in the hierarchical structure through sub-sampling.

10. (ORIGINAL) The apparatus of claim 9, wherein, in a three-stage hierarchical search approach, each of the current and reference frames comprises lowest resolution level (level 2) frame data, intermediate resolution level (level 1) frame data, and highest resolution level (level 0) frame data.

11. (ORIGINAL) The apparatus of claim 10, wherein the highest resolution level (level 0) frame data is the original image, the intermediate resolution level (level 1) frame data has ½ of a width and ½ of a length of the original image, and the lowest resolution level (level 2) frame data has ¼ of the width and ¼ of the length of the original image.

12. (ORIGINAL) The apparatus of claim 10, wherein the ME unit comprises:

a first frame ME unit initiating the frame motion estimation by performing a full search on the lowest resolution level (level 2) frame data and finding at least one initial MV with a minimum Sum of Absolute Difference (SAD);

a second frame ME unit performing local searches on the intermediate resolution level (level 1) frame data using the at least one initial MV, and by finding the initial MVs with the minimum SADs, wherein the initial MVs obtained from the intermediate resolution level (level 1) frame data comprise based MVs; and

a third frame ME unit providing the frame motion estimation and a field motion estimation by searching the highest resolution level (level 0) frame data using the based MVs, and finding frame MVs with the minimum SADs, and field MVs between identical fields that have the minimum SADs.

13. (ORIGINAL) The apparatus of claim 9, wherein Top2Top field MVs are the MVs from a current top field to a previous top field.

14. (ORIGINAL) The apparatus of claim 9, wherein Top2Bot field MVs are the MVs from the current top field to a previous bottom field.

15. (ORIGINAL) The apparatus of claim 9, wherein Bot2Top field MVs are the MVs from a current bottom field to the previous top field.

16. (ORIGINAL) The apparatus of claim 9, wherein Bot2Bot field MVs are the MVs from the current bottom field to the previous bottom field.

17. (ORIGINAL) The apparatus of claim 9, wherein the Top2Top and the Bot2Bot field MVs are obtained based on inter-field SADs obtained from a frame motion estimation.

18. (ORIGINAL) The apparatus of claim 9, wherein the ME unit comprises:

a first scaler scaling the based MVs using a distance between a top field of the current frame and a bottom field of the previous frame;

a first field ME unit performing field motion estimation with local searches between the top field of the current frame and the bottom field of the previous frame;

a second scaler scaling the based MVs using the distance between the bottom field of the current frame and the top field of the previous frame; and

a second field ME unit performing the field motion estimation with the local searches on the bottom and top fields of the current and previous frames, respectively.

19. (ORIGINAL) A method to estimate a motion of an image of frames organized into a hierarchical structure, the method comprising:

performing a discrete cosine transform (DCT) function on the image;

quantizing the DCT function image;

dequantizing the quantized image;

performing an inverse discrete cosine transform (IDCT) on the dequantized image;

storing the IDCT image on a frame-by-frame basis;

forming a hierarchical frame structure by sampling image data of a current frame and the image data of a previous frame stored, and performing a frame motion estimation by applying based motion vectors (MVs); and

removing statistical redundancy from the quantized image based on the MVs estimated.

20. (ORIGINAL) The method of claim 19, further comprising

performing low-pass filtering (LPF) on the current frame and the previous frame and organizing each of the current and reference frames in the hierarchical structure through sub-sampling.

21. (ORIGINAL) The method of claim 20, wherein, in a three-stage hierarchical search approach, each of the current and reference frames comprises lowest resolution level (level 2) frame data, intermediate resolution level (level 1) frame data, and highest resolution level (level 0) frame data.

22. (ORIGINAL) The method of claim 21, wherein the highest resolution level (level 0) frame data is the original image, the intermediate resolution level (level 1) frame data has ½ of a width and ½ of a length of the original image, and the lowest resolution level (level 2) frame data has ¼ of the width and ¼ of the length of the original image.

23. (ORIGINAL) The method of claim 21, wherein further comprising:

initiating the frame motion estimation by performing a full search on the lowest resolution level (level 2) frame data and finding at least one initial MV with a minimum Sum of Absolute Difference (SAD);

performing local searches on the intermediate resolution level (level 1) frame data using the at least one initial MV, and by finding the initial MVs with the minimum SADs, wherein the initial MVs obtained from the intermediate resolution level (level 1) frame data comprise based MVs; and

providing the frame motion estimation and a field motion estimation by searching the highest resolution level (level 0) frame data using the based MVs, and finding frame MVs with the minimum SADs, and field MVs between identical fields that have the minimum SADs.

24. (ORIGINAL) The method of claim 20, wherein Top2Top field MVs are the MVs from a current top field to a previous top field.

25. (ORIGINAL) The method of claim 20, wherein Top2Bot field MVs are the MVs from the current top field to a previous bottom field.

26. (ORIGINAL) The method of claim 20, wherein Bot2Top field MVs are the MVs from a current bottom field to the previous top field.

27. (ORIGINAL) The method of claim 20, wherein Bot2Bot field MVs are the MVs from the current bottom field to the previous bottom field.

28. (ORIGINAL) The method of claim 20, wherein the Top2Top and the Bot2Bot field MVs are obtained based on inter-field SADs obtained from a frame motion estimation.

29. (ORIGINAL) The method of claim 20, wherein the ME unit comprises:

scaling the based MVs using a distance between a top field of the current frame and a bottom field of the previous frame;

performing field motion estimation with local searches between the top field of the current frame and the bottom field of the previous frame;

scaling the based MVs using the distance between the bottom field of the current frame and the top field of the previous frame; and

performing the field motion estimation with the local searches on the bottom and top fields of the current and previous frames, respectively.